Epitomes

Important Advances in Clinical Medicine

Radiology

The Scientific Board of the California Medical Association presents the following inventory of items of progress in radiology. Each item, in the judgment of a panel of knowledgeable physicians, has recently become reasonably firmly established, both as to scientific fact and important clinical significance. The items are presented in simple epitome and an authoritative reference, both to the item itself and to the subject as a whole, is generally given for those who may be unfamiliar with a particular item. The purpose is to assist busy practitioners, students, research workers or scholars to stay abreast of these items of progress in radiology that have recently achieved a substantial degree of authoritative acceptance, whether in their own field of special interest or another.

The items of progress listed below were selected by the Advisory Panel to the Section on Radiology of the California Medical Association and the summaries were prepared under its direction.

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Positron-Emission Tomography of the Heart

MYOCARDIAL PERFORMANCE is determined by complex biochemical processes that modulate contractility, electrophysiologic events and cell viability. In vivo assessment of myocardial metabolism has been difficult to accomplish in the past. Until recently, nuclear cardiologists focused on functional imaging such as the evaluation of myocardial blood flow using thallous chloride Tl 201 and the study of ventricular function by radionuclide ventriculography. With the recent advent of positron-emission tomography (PET), however, the field of nuclear cardiology enters a new era by imaging regional metabolic processes. This tomographic, three-dimensional approach provides quantitative determination of myocardial tracer distribution because photon attenuation can be accurately corrected for. Positron-emitting isotopes such as fluorine 18, oxygen 15, carbon 11 and nitrogen 13 can be used to label physiologically occurring substrates for the in vivo study of myocardial cell function. The current generation of the PET cameras with high spatial (5 to 10 mm) and dynamic resolution (three to ten seconds per image) provide accurate quantitation of myocardial perfusion and metabolism using validated tracer kinetic models. These characteristics make positron-emission tomography a unique tool for the in vivo assay of biochemistry, which links structure and function in a living organism.

In studying the heart, PET has been used mainly in patients with ischemic heart disease and cardiomyopathy. Regional myocardial blood flow is being evaluated using rubidium chloride Rb 82, ammonia N 13 and water O 15, whereas myocardial substrate metabolism is studied using carbon palmitate C 11 as a tracer for fatty acids and fluorine deoxyglucose F 18 (FDG) as an analog for glucose. Using PET, studies in animals and clinical studies have shown that normal myocardium is characterized by a close match of flow and substrate metabolism because both reflect regional energy demand. The same is true for infarcted myocardium where flow and metabolism are low due to the low perfusion and energy requirements of scar tissue. During ischemia, myocardium cannot oxidize fatty acids but uses glucose anaerobically to meet its basic energy requirements. This regional shift in myocardial metabolism during ischemia can be detected noninvasively by PET as shown in experimental and clinical studies. Therefore, ischemic but viable tissue can be detected noninvasively. Using metabolic tissue characterization, studies of animals showed that PET can predict recovery of function following transient ischemia. Encouraged by these results, PET has been applied to patients with acute myocardial infarction. In a considerable number of patients, viable but compromised tissue was observed in "electrocardiographically infarcted" segments of the left ventricle. The metabolic definition of viable but compromised myocardium early during evolving infarction is most important for salvaging myocardium in view of therapeutic interventions such as thrombolysis and angioplasty. Additionally, in patients with severe coronary artery disease and impaired left ventricular function, PET images have been shown to be predictive for the success of a coronary artery bypass procedure. Myocardium with impaired flow but maintained glucose metabolism as estimated by FDG uptake showed functional recovery, while segments with low flow and low metabolism did not recover postoperatively. Because patients with impaired ventricular function have a higher surgical risk, carefully selecting patients for a surgical procedure is clinically important.

In cases of dilated cardiomyopathy, heterogeneous free fatty acid metabolism has been shown by a patchy uptake pattern of carbon palmitate C 11. Furthermore, in patients with severe left ventricular dysfunction, the response of fatty acid metabolism to glucose loading was substantially abnormal. To improve our understanding of the pathophysi-